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and the effects of malaria in a country of paddy fields swarming with mosquitoes, but also taking into consideration the extensive area of more healthful mountain land in Formosa reclaimed from the savages and devoted to tea culture, in which the Japanese excell, one cannot escape the conclusion that here, as in Sakhalin and Korea, Japanese colonial methods fall short at a vital point.

GEOGRAPHICAL ASPECTS OF THE NEW MADEIRA-MAMORÉ RAILROAD

By ISAIAH BOWMAN

The recent completion of the Madeira-Mamoré Railroad about the so-called "Falls of the Madeira" marks the close of a unique chapter in South American geography and history and the opening of a new and remarkable period of commercial development. The Collins railway scheme of 1878-1880 was the first practical attempt to solve the problem, though a canal had been talked of for many years. It followed the brilliant studies* by Col. George E. Church in which the Amazon route to the Atlantic had its most vigorous champion. With the tragic failure of that ambitious enterprise the world has been made acquainted in Craig's belated book.† In our own time we have had a revival of interest in this history-making field through a combination of extraordinary political and commercial events.

The famous quinine industry of eastern Bolivia flourished for many years, but by 1890 it was seriously affected and at last completely undermined by the destructive manner in which the trees were cut and by cheaper production on the plantations of India.‡ Even in its palmy days it paid a heavy tax in transportation. By 1881 cinchona could be gathered only in places almost inaccessible, and the cost of carriage from Bolivia to Europe was no less than

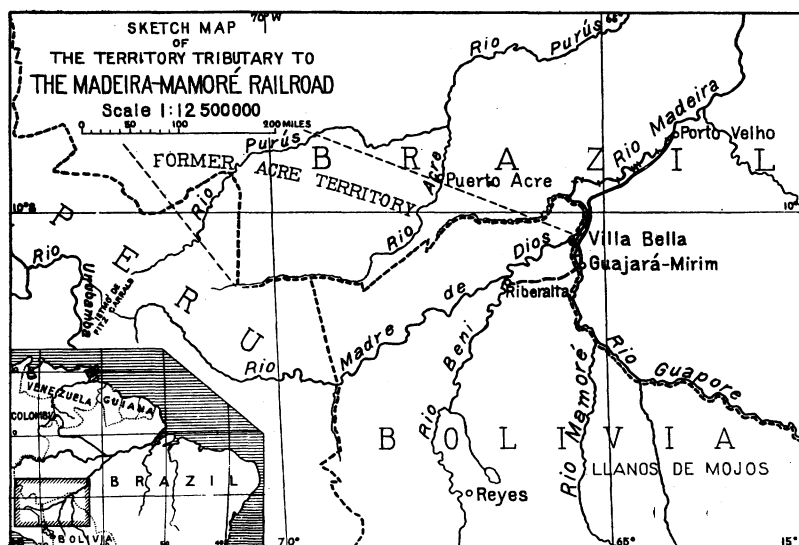
* The Route to Bolivia via the River Amazon. A Report to the Governments of Bolivia and Brazil. 216 pp. Map. Waterlow & Sons, Ltd., London, 1877. The Rapids of the Madeira Branch of the Amazon River. A Preliminary Report upon the Madeira and Mamoré Railway. 1869.

† Recollections of an Ill-Fated Expedition to the Headwaters of the Madeira River in Brazil. By Neville B. Craig. 479 pp. Maps, ills., index. J. B. Lippincott Co., Philadelphia, 1907.

‡ Explorations in the Rubber Districts of Bolivia. By H. Arnous de Rivière. *Bull. Amer. Geogr. Soc.*, Vol. 32, 1900, pp. 432 *et seq.*

\$400 per ton.* The planters became discouraged; not even the gold industry thrived. The only industry to which they could turn was rubber. In making this change they were encouraged by events which can be understood only by reference to the most important explorations in the region.

Down to the time of the Jesuit Fathers but little exploration of the great plains and rivers of eastern Bolivia had been attempted, and its resources were therefore but imperfectly known. The monks brought cattle and seed, organized the famous missions in which they gathered their Indian neophytes, and developed the grassy plains of the Mojos country down to the falls of the Madeira. In 1767 they



were driven out by order of the Church, their people scattered, and much even of their knowledge of the geography was lost. The region once more emerged into the light when Lieutenant Gibbon of the American Navy went down the Chaparé, Mamoré, and Madeira in 1852.† Farther north the feeble explorations of Palacio for the Bolivian government did nothing more than disclose the existence of the falls of Esperanza near the mouth of the Beni.‡ He pro-

* Eastern Bolivia and the Gran Chaco. By J. B. Minchin. *Geogr. Journ.*, Vol. 3, 1881, p. 412.

† Exploration of the Valley of the Amazon made under direction of the Navy Dept. By Wm. Lewis Herndon and Lardner Gibbon. Part II. By Lt. Lardner Gibbon. x and 339 pp. Map, ills. House of Repr., 33d Congress, 1st Session, Washington, 1854.

‡ The Basins of the Amaru-Mayu and the Beni. By C. R. Markham. *Proc. Royal Geogr. Soc.*, Vol. 5, 1883, p. 323.

nounced the river impassable and for a third of a century the lower course was unknown and dreaded by the rubber men. Then came the memorable expedition by Heath in 1880. He descended the river and proved that it was navigable except for the rapids near its mouth, that great resources of rubber were untouched, and that the difficulties owing to savage tribes were exaggerated. Upon his return to Reyes near the Mapiri tributary of the Beni, "Bells were rung, houses decorated, a holiday proclaimed . . . Mass was said, and all seemed to consider my work a public benefit . . . Men became crazed over the rubber prospect, and many sold their cattle and lands to go into the business."* Within four months after his return the number of men collecting rubber on the Beni had increased over 300 per cent., or from 185 to 644.

It thus came about that a new industry sprang up in spite of an insufficient labor supply, great distance from the market, and a choice between frightful mountain trails and a river system interrupted by many dangerous rapids. As soon as development began the vast extent and value of the rubber territory became known, and at once each nation was anxious to get the lion's share of the territory. In the struggle Brazil had one great advantage. Though the larger part of the newly discovered rubber forests lay in Bolivia, it was Brazilian labor that developed it. The alti-plano with its dense population could not supply acclimated rubber collectors, whereas the people of the settlements on the middle and lower Amazon, long engaged in tropical agriculture and rubber gathering, immediately responded to the new call. Brazilians by thousands forsook their plantations to paddle into the rubber country for the adventure of gain in a new and promising field.

It is now worth while briefly to review those historical events that grew out of the treaty relations of the neighboring republics. Brazil had long kept the Amazon country closed in the face of repeated protests, but in 1866 opened the main river and the lower portions of a few of the largest tributaries. This called for a "Treaty of Limits, Commerce, and Navigation," signed in March, 1867, to provide for adequate police and customs regulations. Fifteen out of thirty articles were devoted to the river trade between the two countries whose common lowland frontier cuts squarely across the drainage systems. It was stipulated that Bolivia should have the use of any road that might be built to avoid the falls of the Madeira. The first steamer on the Amazon began running about 1852.† The first

* The Exploration of the River Beni. By E. R. Heath. *Journ. Amer. Geogr. Soc.*, 1882, p. 134.

† Exploration of the Valley of the Amazon. Part I. By W. L. Herndon. 1854.

steamers on the Argentine rivers made their appearance in 1856,* and in the late sixties the development of the interior lowlands of South America was under way. In 1872 it became known that there was an abundance of rubber trees in the Purús district, and by 1878 eight thousand settlers (chiefly Brazilian) were established there. In 1899 the province of Ceará, Brazil, subject to periodic drought, was again stricken, and great numbers of its people emigrated to the rubber country. By 1904 the population of the Purús valley alone had increased to 60,000. By 1884 Brazilians greatly exceeded Bolivians in number on the Purús and its tributaries,† and Brazil at once denounced its treaty of 1867, since it was Bolivian perfidy that stifled the railroad project of 1880, to her own harm no less than to the disadvantage of Brazil. In 1890 Bolivia began what proved to be fruitless negotiations for a new commercial treaty, and in 1899 it established a custom-house at what is now Puerto Acre, on the Bolivian side of the frontier as defined in the treaty of 1867. At this remote "Junta de los Rios" there was at last developed bitter hostility among the Brazilians toward the regulations of government, abetted by a curious concession, on the part of Bolivia to an Anglo-American syndicate, of land and political power amounting to practical sovereignty. The large lawless element in so remote a frontier population would have made some trouble under the best possible circumstances, but the trouble was bound to be grave when the population originated in one country and were working under another whose arm was feeble and its territory vast. Events culminated in a revolution and the proclamation of the ill-starred "Republic of Acre" with Louis Galvez as President, July 15, 1899. Troops were sent thither from both Bolivia and Brazil, but when war seemed imminent the trouble was happily averted by a *modus vivendi* signed at La Paz in March, 1903, and finally by the treaty of Petropolis signed in November of the same year.

By the terms of the treaty of Petropolis, 1903, Bolivia secured a few small tracts of Brazilian territory, while the greater part of the disputed tract, or over 70,000 square miles, were ceded to Brazil. In return the latter country paid Bolivia \$10,000,000 for the development of commerce and transportation and agreed to construct the Madeira-Mamoré Railroad, with a branch to Villa Bella, Bolivia. There is to be perfect liberty of land and water transportation, and both countries have equal privileges in the use of the completed railroad.

* Report on the National Bolivian Navigation Company, 41st Congress, 2d Session, 1869, p. 49.

† The Acre Territory and the Caoutchouc Region of Southwestern Amazonia. By G. E. Church, *Geogr. Journ.*, Vol. 23, 1904, p. 598.

For the past half century eastern Bolivia has been slowly awakening from an age-long sleep. Had it produced no commodity so precious as rubber it is doubtful if that sleep would have been yet disturbed. The heart-breaking task of conveying goods several months up river against the current and thence by mule-back up atrocious mountain trails to the snow-line is only a little more arduous than the two months' task of hauling *batelões* on rollers and transporting the rubber cargo on the backs of human carriers around the many rapids in the two hundred mile stretch between Guajará-Mirim and San Antonio (now Porto Velho). The only other outlet, that over the divide toward Santa Cruz, was equally difficult since a long carry had to be made to get to Santa Cruz where a six weeks' ox-cart journey and fifteen hundred miles of river navigation were still required to reach the sea. Even rubber was at last unequal to the task. The competition of eastern rubber (India and the East Indies) steadily reduced the profits. Furthermore, labor is so expensive in this singularly laborless region that transportation costs actually rose as operations were extended. The railroad became a fundamental condition in the further successful conduct of the rubber business.

Heretofore a few launches have plied on the streams above the falls but the expenses for fuel, transportation of parts, and skilled labor were almost prohibitive. The railroad will make possible a great launch service already in process of development. Power boats of shallow draft can go almost to the foot of the mountains during the wet season. Time was when six feet was considered navigable depth, but three is now regarded practicable. The British gunboat *Widgeon*, 160 feet long, has a draft of only two feet, six inches, which prompts a paragrapher to remark that we are now running a close second to the celebrated western steamboat that could travel on dry land provided a man was sent ahead with a watering-pot. The chief difficulty in extending the launch service is the variable depth of the water. At the falls the difference between high and low water is forty-five feet. However, it is distinctly less on the tributaries near the mountains, and since rubber is a durable crop it can wait for high water, so that practically the whole of the plains country tributary to the Madeira above the falls can be reached by launch. When the railroad to Riberalta (on the Beni above the last falls, sixty-two miles from Guajará-Mirim) shall have been completed it will practically double the accessible area, since the Madre de Dios and its tributaries will also have an outlet.*

* Nuevas exploraciones en la hoya del Madre de Dios, Publicación de la Junta de Vías Fluviales, Lima, 1905. Últimas exploraciones ordenadas por la Junta de Vías Fluviales a los ríos Ucayali, Madre de Dios, Paucartambo y Urubamba. By Stiglich, von Hassel, Olivera, and Ontenada. Lima, 1907.

This great fluvial system crosses a plain that extends up to the base of the mountains. Low divides separate its northerly headwaters from the Mishagua, Camisea and other tributaries of the Urubamba at the famous "Istmo de Fitz-Carrald."* Over this divide might eventually come some of the mountain products, just as when the Acre trouble was at its height some of the Madre de Dios products were taken west and north to the Urubamba and down the Ucayali.†

The possibilities of the region that the railroad and the launches now serve are not limited to rubber, abundant and excellent as the Bolivian product has proved to be. Here are also extensive grass lands, reaching down nearly to the falls, and from Reyes, in the Beni valley near the mountains, eastward beyond the Mamoré. They are the northward prolongation of the grass lands of the Chaco, though here more frequently interrupted by forest tracts. In the palmy days of the Jesuit missions these pastures supported immense herds of cattle,‡ and the happy conditions of the past can be restored. Hides, tallow, and meat products can be produced in great quantities. The shallow basin drained by the Beni, the Mamoré and their tributaries, variously called the Madeira Plate§ or the Mojos depression,|| is subject to overflow in the wet season, but "islands" of elevated land are scattered about where game, stock, and man himself may seek refuge. The inundations favor the growth of the rubber trees and are not wholly detrimental to the grasses of the prairies. Chocolate, vanilla, sugar, hardwoods, and dyewoods are additional products. The easternmost and now remote valleys of the Cordillera on the border of the plains add coca, coffee, and many other products to the list. For we are not now speaking of the typical wet forest of the Amazonian lowlands but of the transition type of forest which grows in the one-wet, one-dry season climate of the upper Madeira basin and of the tracts of grass land interspersed through it in the south, as well as the true grass lands of the middle Mamoré.

The Madeira Railroad* is 202 miles long, has a meter gauge, and a maximum grade of 2 per cent. Construction work began in August, 1907, and the line was completed in July, 1912. The ties

* Recent Discoveries in the Basin of the River Madre de Dios (Bolivia and Peru). By C. R. Markham. *Geogr. Journ.*, Vol. 7, 1896, p. 189. (Deals with first exploration of the route by Fitz-Carrald and others.)

† The Acre Territory and the Caoutchouc Region of Southwestern Amazonia. By G. E. Church. *Geogr. Journ.*, Vol. 23, 1904, p. 598.

‡ The Amazon and Madeira Rivers. By F. Keller. 1874, pp. 145, 153, *et al.*

§ Gibbon, *op. cit.*

|| Church, Keller, and others.

* For maps of the region see *Bull. Amer. Geogr. Soc.*, Vol. 36, 1904 (facing p. 256), and *Petermanns Mitteilungen*, Vol. 52, 1906, Plate 16.

were imported from Australia—and more cheaply than they could be hewed from the resistant tropical woods close at hand. Trains now run regularly from the terminal stations three times a week and take two days to cover the distance. The maximum speed allowed is from 15 to 20 miles an hour. There is wireless connection with Manaos, 500 miles away straight through the forest, and an ice plant and a water system have been in use for some time. More than twenty-five thousand workmen have been employed since work was begun. The mortality among them dropped from 125 per thousand in 1909 to 70 per thousand in 1912.*

Thus in the heart of a river system long closed by imperial edict we have a railroad, a wireless service, a telegraph line, steam launches, a pier for ocean-going steamships, and a great commercial future. The mystery of the Amazon basin diminishes. The recent difficulty between Brazil and Bolivia only serves to emphasize the real reason for the long-delayed development. The irritating exclusiveness of Brazil was not due to the acceptance by old Dom Pedro of medieval standards, as many have supposed, but to a desire to avoid costly boundary disputes and the burden of policing a vast territory long so inaccessible except by "the flowing road" as to make by-words of law and order.

* Valley of the River Amazon—the Madeira-Mamoré Railway Co. By Albert Hale. *Bull. Pan-Amer. Union*, Dec., 1912, pp. 1116-1141. For descriptive articles on the history and construction of the Madeira-Mamoré Railroad, see *idem*, Jan., 1910; March, 1911; and Nov., 1911.

SOIL FLOW

The Berlin Geographical Society has done wisely in preparing this symposium* upon the subject of soil flow, which has only recently come prominently to the notice of geologists and geographers. The various processes to which the name soil flow (*solifluction* of Andersson) has been applied, would appear to be characteristic of sub-polar lands where the surface of the ground is in part snow covered and soaked with thaw water for a considerable season, as well as in those higher lying areas of lower latitudes within which essentially the same conditions prevail. This symposium has come about directly as a result of the International Geological Congress of 1910, which for the first time brought together a large body of geologists in a sub-polar region; though it should be

* A. Miethe, Ueber Karreebodenformen auf Spitzbergen; A. Penck, Ueber Polygonboden in Spitzbergen; H. Spethmann, Ueber Bodenbewegungen auf Island; G. Braun, Ueber Bodenbewegungen in Mittel und Südeuropa; Wilh. Meinardus, Beobachtungen über Detritusortierung und Strukturboden auf Spitzbergen; K. Sapper, Ueber Fließerde und Strukturboden auf Spitzbergen; *Zeitschr. der Gesell. für Erdkunde zu Berlin*, 1912, No. 4, pp. 241-270, 2 pls.